U. S. DEPARTMENT OF COMMERCE

Technical News Bulletin

of the

National Bureau of Standards

Published with approval of the Director of the Budget

★ *Issued Monthly* ★

Washington SEPTEMBER 1937 Number 245

CONTENTS

RESERACH PROGRAM ON BUILDING MATERIALS AND STRUCTURES

Congress recently granted to the Bureau $198,000 for the fiscal year 1937–38 to study the properties and suitability of building materials with particular reference to their use in low-cost housing. A general statement has just been released outlining the objectives, procedure, and scope of the program. Copies of this statement, Letter Circular LC502, Research Program on Building Materials and Structures, 1937–38, may be obtained from the Bureau on request.

The program is being formulated with the advice of representatives of the housing agencies of the Government. The subcommittee on design and construction of the Central Housing Committee has designated a special group to cooperate with the Bureau on this program of technical research. The group consists of Harold D. Hynds, chairman, C. W. Chamberlain of the Procurement Division, Pierre Blouke of the Home Owner's Loan Corporation, Walter Junge of the Federal Housing Administration, Charles Mayette of the Public Works Administration, Vincent B. Phelan of the National Bureau of Standards, Colin O. Skinner of the Resettlement Administration, George W. Trayer of the Forest Service, Capt. Elsmere J. Walters of the Quartermaster Corps of the Army.

The conduct of the program is entrusted to a committee of Bureau division chiefs, P. H. Bates, H. C. Dickinson, H. L. Dryden, W. E. Emley, G. E. F. Lundell, A. S. McAllister, and H. S. Rawdon, under the chairmanship of H. L. Dryden, who is designated as coordinator of the program.

The general objective of the work is to furnish to government agencies, the building industry, and the public, technical information from every available source on the engineering properties of building materials as incorporated in the structural elements and equipment of a house, with particular reference to law-cost housing. This includes new materials, equipment, and methods of construction as well as those already in use. The program will not deal with sociological, economic, hygienic,

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or esthetic questions, or with architectural design. The Bureau does not expect to prepare new house plans.

The detailed programs of the studies on bearing walls, partitions, floors, roofs, heating and ventilating equipment, and plumbing, suitable for use in low-cost housing are now being prepared. Conferences have been held between designated representatives of other government agencies and selected groups of Bureau personnel on the structural properties of low-cost construction; thermal insulation, moisture condensation, and heating and ventilating problems; plumbing; corrosion of steel; weather-tightness of roofs; finish floors; building papers and boards; wiring and lighting.

TOOTH PASTE SPECIFICATION

There has recently been adopted by the Government specification for tooth paste in which thorough laboratory work and service tests are represented, a committee of the Federal Specification Executive Committee having charge of the preparation of this specification.

From the point of view health and money value, a specification for this commodity is of the utmost importance. The Government itself is a large purchaser of this material, a recent order calling for over 150,000 tubes having been placed by one department.

The specification is not a complex one, but it does set forth definite requirements as to what may or may not go into the Government's tooth paste, and it states how tests shall be conducted. The specification covers: Types; materials and workmanship; general and detailed requirements; methods of inspection and test; packaging, packing, and marking; and special requirements applicable to various Government departments.

During the course of the investigation, it was found that of 25 popular brands of tooth paste, all of which contained special materials for which some benefit was claimed, 10 failed to pass the abrasion test now incorporated in the specification, and 11 failed for other reasons. Tests of this kind assist manufacturers by identifying the undesirable ingredients, resulting in their elimination and consequent improvement of the product.

The abrasion test, which is but one of the tests included in the specification, is a very important one because any material which will abrade human enamel must be kept out of a tooth paste. By merely grinding a paste between the teeth, it is possible for an experienced observer to detect 1 per cent of emery in a paste, but the test in the new Government specification, which was developed at the Bureau, will detect the presence of emery or materials having similar abrasive qualities if present in amounts of 1 part in 100,000, or one thousandth of 1 percent. Even so, the test for abrasives is simple as will be noted from the following:

"E–5. The tooth paste shall not scratch glass."

"F–1e (1). Tooth paste shall be placed on glass and rubbed with a copper alloy similar in composition and shape to the 5-cent coin which has previously been rubbed against glass without scratching. The glass shall be of the usual soda-lime grade such as is used in noncorrosive microscope slides."

Limits are set for acidity and alkalinity values.

The Government has found that the use of Federal Specification FFF–D–191 will enable its purchasing officers to secure a satisfactory article on the basis of free competition and at the lowest price consistent with the necessary quality. Copies are obtainable at 5 cents each from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Any manufacturer who is certain that his product complies with Federal Specification FF–D–191 is at liberty to say so on the label of his product. Such marking would give to the general public many of the benefits which will be secured by the Government.

The Bureau does not make routine or commercial tests of tooth paste, except for other branches of the Government. Any well-equipped chemical testing laboratory can make the necessary tests for compliance with the specification.

A report of the investigation was presented at a recent meeting of the American Dental Association and will be published in an early number of their Journal. Trade names are not mentioned in the report.

PROBLEMS OF STATIONARY FLAMES

The usefulness of flames in their more familiar application (called stationary flames to distinguish them from flames in gas engine cylinders, etc.) is dependent on their stability and susceptibility to control. The burner is the control device, and the problems of flames and burners are inextricably interwoven. Of the various factors which influence the stability and determine the behavior of flames on burners, the speed of the flame rela-

tive to the combustible mixture plays the dominant role.

One of the methods in use for determining flame speed involves measurements of the stationary flame surface and the rate of flow of the combustible mixture. The method is relatively simple and, within limitations, the results can be used (*a*) to compare different combustible mixtures with respect to flame speed and (*b*) in the solution of a multitude of problems involving flames and burners.

For several years Francis A. Smith of the Bureau's Chemistry Division has studied flames and burners and has compared his conclusions with those of other workers. A brief presentation of the results of this work forms a part of the symposium on gaseous combustion published in Chemical Reviews, *21*, no. 3 (1937).

Unfortunately, burner methods appear to yield reliable results within only a limited range of operating conditions.

Measurements of the angle between flame surface and axis at a point 0.7 r from the axis, on flames resulting from mixtures in laminar flow at or near the composition for maximum flame speed, and on burner ports over 4 millimeters in diameter, yield results least affected by variations in experimental conditions.

Comparisons between different fuel gases can be made only by measuring maximum flame speeds, because so far as composition is concerned, there is no common basis for comparison.

An appreciable redistribution of velocities in the stream of mixture occurs as the stream leaves the port, and this affects the shape of the flame surface.

Laminar flow, favored by deep and/or small ports, increases the range of stable operation between the limits of flash-back and blow-off. Complete mixing and low proportions of air do likewise. Such conditions also tend to eliminate turbulence and noise.

The obvious fact that the temperature of a body being heated rises only until the rate of heat loss becomes equal to the rate of heat supply is often overlooked in selecting a flame for a particular purpose.

In choosing the dimensions of a burner for greatest stability with a given flame, a likely value for the average velocity (in laminar flow) of maximum-speed mixtures with air will be from six to seven times the maximum flame speed.

Maximum flame speed, rather than flame temperature or heating value of the fuel gas, is the key to the liberation of heat at the highest rate in a given space for the production of local high temperatures. The heating value of the maximum-speed mixture, multiplied by the maximum flame-speed, is an index to intensity of combustion (Btu per second per unit area).

MEASUREMENT OF FLAME SPEEDS IN ENGINE CYLINDERS

Although the modern internal-combustion engine has attained a high state of mechanical development, many important details of its combustion process remain obscure. There is need for a better understanding of the micro-mechanism of flame propagation, and of the effects of operating factors on the speed at which flame propagates through the explosive charge. In recognition of this, the National Advisory Committee for Aeronautics has sponsored research at the Bureau to obtain fundamental information on gaseous explosions. A paper by Ernest F. Fiock and Charles F. Marvin, Jr., which will be presented at the American Chemical Society's meeting in September reviews past work and outlines the present program at the Bureau.

Flame speeds have been measured during explosions at constant pressure and at constant volume. In the constant pressure method, which has been in use for a number of years, a soap bubble is blown with explosive mixture and fired by a spark at its center. The spark initiates a tiny sphere of flame which grows rapidly, maintaining its spherical shape, until all of the mixture is burned. The travel of the flame is recorded on a moving film and the photograph is analyzed to show the speed of the flame front in space and with respect to the unburned charge. This method, which is relatively simple and accurate, has been used successfully to study the effects of changes in fuel-oxygen ratio and dilution of the charge with inert gases, but is adapted only to a limited range of conditions.

The constant-volume method, in which explosions occur in a closed bomb, although more complicated, permits investigation of the independent effects of pressure, temperature, and charge composition over a much wider range of conditions. In this method the movement of the flame and the accompanying rise in pressure must both be recorded if the rate of flame propagation with respect to the unburned gas is to be determined. A spherical steel bomb with central ignition and auxiliary equipment for obtaining simultaneous records of flame travel and pressure rise has been constructed and experiments are now in progress. It is hoped that the data

obtained will clarify the mechanism of flame propagation and suggest practical means for further control of gaseous explosions.

PARAFFIN HYDROCARBONS ISOLATED FROM CRUDE SYNTHETIC ISOOCTANE

In 1934 the Cooperative Fuel Research Committee requested the Bureau to develop specifications for normal heptane and for the isooctane (2, 2, 4-trimethylpentane) which are used as primary standards of reference for the knock rating of automotive fuels.

In carrying out the investigation of the isooctane, over twenty isoparaffins were obtained in a relatively pure state. Some of these compounds have not been described previously, and several others are decidedly purer than previous preparations.

The materials were isolated by fractional distillation through columns packed with locket chain and having an efficiency of about 60 plates, and were purified by low-temperature crystallization.

In measuring the physical properties, care was taken to obtain the highest accuracy on materials of high purity. The properties measured included in most cases the boiling point, freezing point, density, refractive index, American Society for Testing Materials' octane number, the coefficients of variations of refractive index and density with temperature, and the coefficient of variation of boiling point with pressure.

This work, which was conducted by Donald B. Brooks, Robetta B. Cleaton, and Frank H. Carter, is more fully reported in the September number of the Journal of Research (RP1027).

HEATS OF FORMATION OF THE SIMPLE ORGANIC MOLECULES

The following is the abstract of a paper by Frederick D. Rossini to be presented at a symposium on characteristic properties of hydrocarbons and their derivatives as related to structure, which will be held by the Division of Petroleum Chemistry at the meeting of the American Chemical Society in Rochester, N. Y., September 6 to 10, 1937.

Within the past 15 years, the simpler organic molecules have assumed an importance of new magnitude in the chemical and petroleum industries, where they are being treated in many different types of reactions (such as addition, polymerization, oxidation, hydration or dehydration, hydrogenation or dehydrogenation, and decomposition of "cracking") to produce, on a large scale, molecules hitherto available only in the laboratory. In the petroleum industry, especially, some of the above reactions are being prosecuted on a large scale to produce superior fuels for internal-combustion engines in quantities which are increasing almost geometrically.

After the first rush of success in any virgin field of endeavor, the increase of competition makes necessary greater economy in operation and higher efficiency in processing methods. Inquiry must then be made as to whether the chemical reactions involved in the given processes are being carried on under conditions which will insure the greatest economy and highest yield. Given an appropriate catalyst, the question as to whether the reaction will proceed at all in the desired direction, and to what extent, under given conditions of temperature and pressure, can be answered by the empirical and costly methods of trial and error or by simple calculations from the thermodynamic constants of the substances involved. One of the most important factors in this latter calculation is the heat of the given reaction; and an accurate value for this must be known to obtain a reliable thermodynamic analysis of the process.

Another value of data on heats of formation lies in the more fundamental question of the energies of the atomic linkages in these molecules—the energy of binding which keep atoms together in certain preferred structural relationships. These bond energies are important in the calculation of energies of activation and rates of reaction, which yield information concerning the "mechanism" of given reactions. While certain other data are also required in evaluating bond energies, the heats of formation is the keystone in the calculation.

In Doctor Rossini's paper, the following subjects will be discussed: The evaluation of heats of formation; the existing thermochemical data on the simple molecules (with from 1 to 6 or 7 carbon atoms) of the various classes (paraffin hydrocarbons, olefin hydrocarbons, naphthene or cycloparaffin hydrocarbons, aromatic hydrocarbons, alcohols, ethers, ketones, aldehydes, acids, amines, cyanides or nitriles, sulfur compounds, and halogen compounds); bond energies and "atomic" heats of formation; and regularities in the heats of formation.

Until comparatively recently the great body of the thermochemical data on organic compounds was dependent upon experimental results obtained

from 30 to 80 years ago, in the European laboratories of Thomsen, Berthelot, Louguinine, Zubow, Stohmann, and others. In connection with these old data, two points must be emphasized: First, these early investigators and their coworkers performed exceedingly well with the meager apparatus and the more or less impure materials that were available to them; second, these old data fall short of meeting the present day requirements of accuracy, which have increased tenfold or more in the past half century.

This latter point is exemplified by the following comparison between the "old" values of the heats of combustion of some gases, taken from the International Critical Tables, and new values recently obtained at the National Bureau of Standards:

Substance (gas)	Heat of combustion at 25° C.		
	Old value (from International Critical Tables)	New value	Difference
	kcal/mole	*kcal/mole*	*kcal/mole*
CH_4	210.6	212.79±0.07	2.2
C_2H_6	368.2	372.81±.11	4.6
C_3H_8	526.0	530.57±.12	4.6
n-C_4H_{10}	[1]	687.94±.15	
i-C_4H_{10}	683.0	686.31±.13	3.3
n-C_5H_{12}	837.8	845.27±.21	7.5
C_3H_4	332	337.28±.07	5.3
C_4H_8	490.0	491.82±.15	1.8
CH_3OH	179.7	182.58±.05	2.8
C_2H_5OH	338	336.80±.10	−1.2

[1] No data.

The above differences are of such magnitude that, if there are no compensing factors, the calculated equilibrium constants at 380° C. will be changed by factors ranging from 2.5 to 300.

From the survey of the existing data, it is concluded that new measurements are needed for all the simple organic molecules, with the exception of the normal paraffin hydrocarbons, the olefin hydrocarbons, and the primary normal alkyl alcohols, accurate values for which are now available.

HEATS OF COMBUSTION AND OF FORMATION OF THE NORMAL OLEFIN HYDROCARBONS

In recent years, the olefin gases have become very important in industry in the synthetic production of various chemicals and of high-grade motor fuels. An accurate knowledge of their heats of formation is necessary for the proper thermodynamic derivation of the conditions for carrying on these processes most economically. In RP1028 in the September number of the Journal of Research, Frederick D. Rossini and John W. Knowlton review and correlate the existing thermochemical data on the normal olefin (alkene–1) hydrocarbons. These data have been used in conjunction with the value recently proposed for the increase in the heat content per added CH_2 group to deduce values for those members of this series of hydrocarbons for which no calorimetric data exist. For all these hydrocarbons in the gaseous state, "best" values have been selected for the heats of combustion at 25° C., and at the absolute zero of temperature.

As in the case of the Bureau's previously reported data on the normal paraffin hydrocarbons and primary normal alkyl alcohols, the heats of formation of the gaseous normal olefin (alkene–1) hydrocarbons, ethylene, propylene, normal butene–1, normal pentene–1, etc., can be represented by means of an expression of the form $\Delta H = A + Bn + \Delta$, where ΔH is the heat of formation, A and B are constant for a given temperature, n is the number of carbon atoms in the molecule C_nH_{2n}, and Δ is a term giving the deviation from linearity, which is zero for $n > 5$. Values of the constants A and B and of Δ have been tabulated both for 25° C and for 0° K.

HEATS OF COMBINATION OF ETHYLENE AND PROPYLENE

Ethylene and propylene are two hydrocarbon gases which have become very important within recent years, because of their availability (of the order of 100,000,000,000 cubic feet annually) as byproducts from the "cracking" processes of the petroleum industry, because of their use in the synthetic production of alcohols and other chemical substances, and because of their utility in the making of motor fuel of high antiknock value by the newly developed polymerization processes.

If such processes are to be carried on most economically and profitably, there must be known accurate values for the heats and free energies of formation of these substances. Notwithstanding the importance of ethylene and propylene in these industrial processes, their existing values of heats of formation depend upon measurements made about half a century ago. Because data obtained at the Bureau several years ago showed that the old "accepted" value for the heat of combustion of ethane was in error by about 4 kilo-calories per mole, it was suspected that the old "accepted"

values for ethylene and propylene might also be seriously in error. A redetermination of these two important thermo-dynamic constants was therefore undertaken by Frederick D. Rossini and John W. Knowlton, and the work which has now been completed, is reported in the Journal of Research for September (RP1024).

The results of these new measurements show, for ethylene, a discrepancy even more startling than that previously found for ethane. The new value for ethylene differs by about 5 kilo-calories per mole from the old "accepted" value, and the new value for propylene differs by about 2 kilo-calories per mole from its old "accepted" value. In terms of the heat evolved in the combustion of the gas in oxygen to form gaseous carbon dioxide and liquid water, all at 25° C. and a constant pressure of 1 atmosphere, the new values are: Ethylene, 337.28±0.07 kilo-calories per gram-mole; propylene, 491.81±015 kilo-calories per gram-mole.

PHYSICOCHEMICAL CONSTANTS OF BENZENE

RP1029 by Mieczysław Wojciechowski, in the September number of the Journal of Research, describes recent measurements of certain physicochemical constants of benzene.

Benzene was purified by four different methods resulting in a number of preparations of a very high degree of purity. The following physicochemical constants were measured: Boiling point, 80.094°, freezing point, 5.51 ° C; refractive index n^{25} 1.49807; and density at 25° 0.87366 g/cm³. Previous determinations of these constants, as reported in the literature, are also reviewed in this paper. The work shows that benzene can be obtained in a state of purity sufficiently high to warrant its use as a secondary standard substance for determining physicochemical constants by comparative methods.

MOLECULAR VOLUMES AND EXPANSIVITIES OF LIQUID NORMAL HYDROGEN AND PARAHYDROGEN

Although ordinary hydrogen may contain a very small amount of heavy hydrogen, it is essentially a mixture of two kinds of molecules, ortho and para, having the same molecular weight but differing in many, if not all, of their other physical properties. The concentration normally encountered is 75 percent orthohydrogen molecules and 25 percent of parahydrogen molecules. By cooling the hydrogen to a very low temperature in the presence of a suitable catalyst it is possible to convert the orthohydrogen molecules to parahydrogen, and almost pure parahydrogen may be obtained in this way.

It is of interest in studying the properties of hydrogen to know how far apart the molecules are spaced in the liquid, and how much ortho and para hydrogen differ in this respect. These questions have been answered as the result of work by Russell B. Scott and Ferdinand G. Brickwedde, in which the volumes of certain amounts of liquid normal hydrogen, and parahydrogen, were measured at temperatures between 14° and 20° absolute. The volumes were determined in a bulb made of fused quartz, a material that has a very low coefficient of expansion; hence, the capacity of the bulb changed very little when it was cooled to the low temperature. It was found that the density of liquid parahydrogen was one-half percent greater than that of normal hydrogen at the same temperature. These measurements, which are reported in the September Journal of Research (RP1023), constitute the first determination of the density of liquid parahydrogen.

EXTRACTION OF LEVULOSE FROM JERUSALEM ARTICHOKES

Experiments conducted at the Bureau in 1925 by Proffitt, Bogan, and Jackson first demonstrated that the natural levulose compounds, or polysaccharides, contained in the tubers of jerusalem artichokes, can be extracted through the medium of hot water in the apparatus known as the diffusion battery. In this process, as in the diffusion of cane sugar from beets in the same type of equipment, a considerable proportion of the extractives is transferred from the plant substance into the water by dialysis through the vegetable tissues. Since the polysaccharides are composed mainly of molecules which are exceedingly large compared with the molecules of cane sugar, it is interesting to find that the rate of extraction, nevertheless, is comparable with the rates obtained in the diffusion of cane sugar from beet cossettes, and that the resulting residues of the extractives in the pulp and pulp water discarded from the process can be reduced to a feasible degree, involving no excessive rejectment of levulose. Experiments recently conducted by Max J. Proffitt, John A. Bogan, and Richard F. Jackson, indicate that the pulp can be pressed and dried, yielding a quantity of dried pulp equal to about 4.3 percent of the weight of the origi-

nal artichoke cossettes. This is somewhat less than the average yield of dried beet pulp from beet cossettes, but analysis indicates that the dried artichoke pulp should have a feeding value for livestock which is superior to that of beet pulp.

A more complete account of this work will be published as RP1025 in the September number of the Journal of Research.

EVALUATION OF MOTION-PICTURE FILM FOR PERMANENT RECORDS

Libraries are rapidly becoming important users of motion-picture film of the safety type, not for amusement purpose, but for the preservation of records. The use of films facilitates rapid and inexpensive copying of records. Hence the contents of rare books and other documents can be made readily available for the first time. Also an economical method is provided for preserving the great volume of important records that are now on perishable papers of the newsprint type. The cellulose acetate, or safety-base film, has been found to have excellent keeping qualities if properly made and properly processed photographically. Miscellaneous Publication M158 of the National Bureau of Standards, by John R. Hill and Charles G. Weber, on the evaluation of motion-picture film for permanent records describes how film should be tested to determine whether it has been so made and processed. Both chemical and physical tests are proposed, and it is recommended that tests be made before and after an oven-aging treatment to find the probable resistance to aging.

Copies of this publication may be obtained at 5 cents each from the Superintendent of Documents, Government Printing Office, Washington, D. C.

OPTICAL SPECIFICATION OF LIGHT-SCATTERING MATERIALS

In 1931 Kubelka and Munk worked out the relationship between reflectance and thickness of material for thin, homogeneous layers illuminated diffusely. In the equation expressing this relationship, the hypothetical ideal material is defined by two constants, reflectivity and coefficient of scatter. Reflectivity is the reflectance of a layer of the material so thick that it is opaque; coefficient of scatter is the rate of increase of reflectance with thickness for very thin samples over a black backing. The advantage of using the Kubelka-Munk equation as a basis for specification of light-scattering materials lies in the fact that once the reflectivity and coefficient of scatter of an homogeneous material are found, the equation indicates the reflectance and opacity of a sheet of the material of any thickness. If this equation could be applied to paint, paper, or vitreous enamel, the manufacturer of these products could compute how thick a layer would be required to meet specifications in terms of reflectance or opacity. He could also compute how much the effect of adding a non-scattering absorbing material (such as lamp black or dye) would be; and he could discover how much gain in opacity or hiding power is necessarily associated with a given drop in reflectance from this cause.

In RP1026 in the September number of the Journal of Research, Deane B. Judd gives data demonstrating how well several materials of commerce can be specified by these constants. These include vitreous enamel, dental silicate cement, cold-water paint, and paper. In spite of the numerous differences between real materials and the ideal material to which the Kubelka-Munk equation applies, and in spite of deviations in technique from that assumed in the derivation of the equation, it has been found that the formula applies to these particular materials within the experimental uncertainty. Several charts giving at a glance accurate numerical solutions of the Kubelka-Munk equation for nearly all cases of interest for near-white materials have been prepared, and are reproduced to a scale large enough for practical use.

OPTICAL SPECIFICATION OF VITREOUS ENAMELS

Since the reflectance or brightness of a vitreous enamel coating varies with its thickness, and different enamels at the same thickness have different brightnesses, it would be desirable to evaluate the reflection constants of enamels so that the reflectance of each enamel of known constants could be predicted for any given thickness. Kubelka and Munk in 1931 developed a theoretical formula from which this may be done for any material conforming to the assumptions of the theory. A study was carried out by Deane B. Judd, W. N. Harrison, and B. J. Sweo, to determine whether a description of the reflectance characteristics of vitreous enamels in terms of this theory is sufficiently exact to be of value. It was found that, in spite of differences between enamels and the ideal material assumed in the theory, the data fit the theory within experimental error. Also, graphical aids for applying this theory to data are presented.

DEFORMATION AND YOUNG'S MODULUS IN FLEXURE OF FIRE-CLAY BRICK

The ability of firebrick to resist deformation (elastic and plastic) at operating temperatures of certain types of industrial furnaces is an important factor in the life of the latter. The employment of heat insulating materials on installations where they have not been formerly used as, for example, roofs of open hearth and certain types of heat-treating furnaces, has greatly increased the possibility of plastic deformation of bricks exposed directly to the heat of such furnaces. The reason is that the insulation reduces the temperature gradient within the brick, as compared with uninsulated firebrick.

The strength and Young's modulus of elasticity of the average high heat duty fire-clay brick at furnace temperatures are small in comparison with those at room temperature; therefore, the relative resistance of any particular product to deformation at high temperature is probably due largely to the nature and quantity of the existing glassy bond. The proportion, type, and sizes of the aggregate, as well as the compactness of the entire structure, must also have a decided bearing on the total deformation. After the glassy phase present in the brick begins to soften, with further increase of temperature, a greater proportion of the total deformation will then be due to plastic flow. This is because the viscosity of the glass has been lowered and the resistance to deformation must then depend mainly on the aggregate and crystal growths.

Recently, Raymond A. Heindl and William L. Pendergast, completed a study of the elastic and plastic deformations at 1,220° C of 17 brands of fire-clay bricks reheated at 1,400° and at 1,500° C, and also of 8 of the brands as received from the manufacturer. Young's modulus of elasticity of the specimens in flexure, and the transverse strength were determined at 1,250° C for the bricks as received and also after reheating at 1,400° C.

The following results were obtained:

1. The total deformation of specimens reheated at 1,400° C increased in general with increase in quantity of particles in the raw brick batches retained on a United States standard sieve no. 40, as well as with increase in the ratio of total flux to total silica present; after having been reheated at 1,500° C, particle size is no longer an important factor.

2. In general, the data indicate that bricks formed by the dry-press process have uniformly high deformations, the stiff-mud type low deformations, and the hand-made type have deformations covering the range of the other types.

3. The deformation decreased greatly after reheating at 1,400° and at 1,500° C in comparison with that obtained on the material as received. The bricks high in silica showed the least change in deformation after the heat treatments. Microscopic examination showed successive decreases in glass content and increases in the crystallization of mullite with the reheating. Specimens of low deformation, when tested as received, were either of the siliceous type or contained considerable quantities of mullite crystals. Much glass was present in those which showed high deformations.

4. Young's modulus of elasticity of specimens in bending at 1,250° C on materials tested as received from the manufacturer was less than 200,000 lb/in.^{2} for 11 of the 17 specimens tested. In most cases the value at 1,220° C was less than 10 percent of the value at approximately 20° C reported previously. After heating at 1,400° C, the modulus of elasticity was approximately double that obtained on the bricks as received. The strength of the reheated specimens also increased greatly with the reheating, but was much less than values obtained at room temperature.

CORROSION OF METALS IN SOILS

In the design of any underground metallic structure, such as a pipe line, one of the important considerations is the rate at which the metal is corroded by the soil. Usually the builder may choose between several ferrous materials, and in some cases it is even possible and economical to use nonferrous metals such as copper and lead. Bituminous, metallic, and other types of coatings may also be used to protect the pipe line.

The relative merits of the commonly used ferrous materials, cast iron, wrought iron, and steel, has been a controversial question for many years. There is no essential reason why any one of the wrought ferrous materials should be superior to the others, because the composition and structure of all of them are essentially similar. However, it is of considerable importance to know whether the corrosion resistance of these alloys can be improved by adjusting their composition within the limits of good manufacturing practice.

Dr. Scott Ewing, research associate of the American Gas Association, has

compared the composition of the 8 wrought ferrous materials in the soil corrosion test of the National Bureau of Standards with the average pitting rate over a period of exposure of 12 years in 23 test sites. The only alloying element which appears to have any effect on the pitting rate is phosphorus. The pitting rate decreases slightly as the phosphorus content is increased up to about 0.1 percent. This result is in rough accord with the atmospheric corrosion test results of the American Society for Testing Materials.

The conditions in soils which cause corrosion of lead and copper have also been considered, using the Bureau's results for these metals. Lead, while usually more resistant than the ferrous metals, is pitted to greater depth in 6 out of 47 test locations. In these soils the content of sulphates is very low and the soil is about neutral (pH7) in reaction. Lead is practically unaffected in soils containing large amounts of sulphates. Copper is, in general, more resistant than either lead or steel. It is seriously attacked in cinders and tidal marshes. In soils containing relatively large amounts of chloride and carbonates the attack of copper is appreciable but usually not serious.

Heavy zinc (galvanized) coatings have been found to afford good protection to steel pipes under the conditions of the tests, while lead-coated steel is usually seriously pitted. The essential reason for this difference in these metals is that zinc is anodic to steel while lead is cathodic.

NEW AND REVISED PUBLICATIONS ISSUED DURING AUGUST 1937

Journal of Research[1]

Journal of Research of the National Bureau of Standards, volume 19, number 2, August 1937 (RP1016 to RP1022, inclusive). Price, 25 cents. Obtainable by subscription.

Research Papers[1]

[Reprints from the June and July 1937 numbers of the Journal of Research]

RP1000. Study of the crystal behavior of hydrocarbons. Robert T. Leslie and Wilson W. Heuer. Price, 10 cents.

RP1001. Characteristics of the ionosphere and their application to radio transmission. Theodore R. Gilliland, Samuel S. Kirby, Newbern Smith, and Stephen E. Reymer. Price, 10 cents.

RP1002. Accelerated weathering tests of mineral-surfaced asphalt shingles. Hubert R. Snoke and Braxton E. Gallup. Price, 10 cents.

RPE003. Compressibility of fused-quartz glass at atmospheric pressure. Walter B. Emerson. Price, 10 cents.

RP1004. Behavior of leather in the oxygen bomb. Joseph R. Kanagy. Price, 5 cents.

RP1005. Compensation of strain gages for vibration and impact. William M. Bleakney. Price, 5 cents.

RP1006. Experiments with underground ultra-high-frequency antenna for airplane landing beam. Harry Diamond and Francis W. Dunmore. Price, 10 cents.

RP1008. Arc and spark spectra of lutecium. William F. Meggers and Bourdon F. Scribner. Price, 5 cents.

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RP1013. Extension of normal-incidence ionosphere measurements to oblique-incidence radio transmission. Newbern Smith. Price, 5 cents.

RP1014. Gases in some optical and other glasses. Clarence Hahner, George Q. Voigt, and Alfred N. Finn. Price, 5 cents.

RP1015. Wick test for efflorescence of building brick. John W. McBurney and Douglas E. Parsons. Price, 5 cents.

Circulars[1]

Supplement to NBS Circular C398. Standard samples issued or in preparation by the National Bureau of Standards. (June 3, 1937.) Free on application to the Bureau.

Simplified Practice Recommendations[1]

R38–37. Sand-lime brick. (Supersedes R38.) Price, 5 cents.

[1] Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research, $2.50 per year (United States and its possessions, and Canada, Cuba, Mexico, Newfoundland, and the Republic of Panama); other countries, 70 cents and $3.25, respectively.

Commercial Standards[1]

CS39–37. Wool and part-wool blankets. (Supersedes CS39–32.) Price, 5 cents.

Technical News Bulletin[1]

Technical News Bulletin 244, August 1937. Price, 5 cents. Obtainable by subscription.

MIMEOGRAPHED MATERIAL

Letter Circulars

Letter Circulars are prepared to answer specific inquiries addressed to the National Bureau of Standards and are sent only on request to persons having definite need for the information. The Bureau cannot undertake to supply lists or complete sets of Letter Circulars or to send copies automatically as issued.

LS502. Research program on building materials and structures, 1937–38.

LC502A. Structural properties of low-cost house construction.

Technical Information on Building Materials

The supply of these notes, each of which consists of three or four pages giving the important facts on some one aspect of the properties or use of building materials, is necessarily limited. Their distribution will be confined to Government officials concerned with building projects, and to architects, engineers, and home builders. Requests should make clear the actual need for the information at the time of writing. Letters should be addressed to the Division of Codes and Specifications, National Bureau of Standards, Washington, D. C. The following note was issued since the list published in the August 1937 number of the Technical News Bulletin:

TIBM–51. Shingles; mineral-surfaced asphalt.

Reports of National Hydraulic Laboratory

Copies are sent only in answer to specific requests addressed to the National Bureau of Standards.

Current hydraulic laboratory research in the United States, Bulletin (series A), V–2 (July 1, 1937).

RECENT BUREAU ARTICLES APPEARING IN OUTSIDE PUBLICATIONS[2]

Explorations in the superconducting state. Francis B. Silsbee. J. Wash. Acad. Sciences (c/o H. G. Avers, Coast and Geodetic Survey, Washington, D. C.), 27, 225 (June 15, 1937).

Characteristics of the ionosphere and their application to radio transmission. T. R. Gilliland, S. S. Kirby, N. Smith, and S. E. Reymer. Proc. Inst. Radio Engineers (33 West 39th St., New York, N. Y.), 25, 823 (July 1937).

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Behavior of leather in the oxygen bomb. Joseph R. Kanagy. J. Am. Leather Chemists Assn. (Ridgeway, Pa.), 32, 314 (July 1937).

Laboratory apparatus and method for determining the resistance of sole leather to abrasion. E. L. Wallace. J. Am. Leather Chemists Assn., 32, 325 (July 1937).

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Wear testing. S. J. Rosenberg. Metal Progress (7016 Euclid Ave., Cleveland, Ohio), 17, 65 (July 1937).

Diffusion in solid metals. A correlated abstract. I and II. Metals and Alloys (1117 Wolfendale St., Pittsburgh, Pa.), 8, 138 (May 1937) and 173 (June 1937).

Locating the causes of rain penetration of brick walls. D. E. Parsons. Building Economy and the Modern Brickbuilder, Cleveland, Ohio), 12, 5 (July 1937).

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